

**The International  
Journal  
of  
Levant  
Studies**

Vol. 4 / 2022

Bucharest, 2023

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The front cover shows an image of Histria fortress, the oldest Greek settlement in Dobrogea, Romania (7<sup>th</sup> century BC).

ISSN 2734 – 6544, ISSN-L 2734 – 6544



Editura MEGA | [www.edituramega.ro](http://www.edituramega.ro)

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## Geologic Influences on the Natural Resources of the Levant

Barney Paul Popkin

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**Abstract:** Geology contributes to, and with climate, determines a region's terrain. The Levant, the dominant region of the Eastern Mediterranean in West Asia, is largely devoid of natural resources, though what resources it has are diverse. These natural resources from the over 250,000 square miles area which stretch from coastal southeastern Turkey to northeastern Egypt, consist mainly of thin, calcareous, thin, calcareous, carbon-deficient, alkaline, and sodic desert soils, rocks and minerals, plants, and wildlife.

Surprisingly, the Levant includes diverse but locally limited natural resources. The sea provides aquatic crops, animal feed, and foods and is the source material for desalination to produce drinking water and to mix with treated wastewater for producing industrial and irrigation water. Small tidal variation of less than 20 inches (often hidden by atmospheric conditions) is too low to produce tidal energy. The Mediterranean, Dead Sea, Gulf of Aqaba, and inland fresh-water lakes attract adventurers and tourists. Inland mountains, and ubiquitous hot rocks at depth and extensive sunlight provide hydro, geothermal, and solar energy. Limestone, marble, sand and gravel, and clay provide building and facing stones, sculpture material, mosaics, underground shelters and subway train networks, construction materials, pottery and ceramic glazes, cosmetics, and health treatment materials. Fossil resin (amber), spices (cumin, cinnamon, nutmeg, cardamom), precious stones (lapis lazuli, carnelian, turquoise), salt, phosphides, wild wheat, lentils, and peas, olives, and natron (sodium-rich) glass are valuable exports. Oil and natural gas are present offshore. Pine forests, shrubs, olive, and nut trees provide habitat for wildlife, especially birds and small mammals.

Several of these resources are important to industry, food, and even warfare. Levant salt was used as primitive currency, for salting soil and wells during warfare in the ancient world, preserving meat, fish, vegetables, and fruit, processing leather, glazing ceramics, dyeing textiles, separating gold from silver, and making cheese, medicines, and cosmetics.

**Keywords:** geology, Levant, Eastern Mediterranean, rocks, minerals, natural resources

## 1. Introduction

The Levant is a large and ancient historic region in the Eastern Mediterranean of Western Asia. It links Europe, Asia, and Africa by land and by sea. Its sea and land routes have been trading routes throughout recorded history. The Mediterranean Sea lies to its west. The Fertile Crescent lies to its east. The Eastern Mediterranean Sea covers about 40,000 square miles, about 1.9 times larger than the Western Mediterranean. Its shoreline is suitable for seaports and harbors.

The Levant covers over 285,000 square miles. It includes parts of southeastern Turkey (Anatolia and Hatay), Greek Dodecanese Islands, Cyprus, all of Lebanon, Israel, Gaza, and much of Syria and Jordan. Some authorities consider coastal Sinai and northeastern Egypt as within the Levant. Levant's seacoast is over 5,000 miles long. Mediterranean climate of limited winter rains, high evaporation and plant transpiration rates, low humidity, strong-windy coasts, acting on its rocks for millennia produce thin, calcareous, carbon-deficient, alkaline, and sodic desert soils, rocks and minerals, plants, and wildlife. Its population is about 45 million people, mostly in the urban areas of Aleppo, Damascus, Amman, Beirut, Jerusalem, Tel Aviv, Gaza City, and perhaps Alexandria.

## 2. Natural Resources

For a desert, it is surprising that the Levant includes diverse but locally limited natural resources. The sea of course provides aquatic crops, animal feed, and foods and is the source material for desalination to produce drinking water and to mix with treated wastewater for producing industrial and irrigation water. Small tidal variation of less than 20 inches (often hidden by atmospheric conditions) is too low to produce tidal energy. The Mediterranean, Dead Sea, Gulf of Aqaba, and inland fresh-water lakes attract adventurers and tourists. Inland mountains, and ubiquitous hot rocks at depth and extensive sunlight provide hydro, geothermal, and solar energy. Limestone, marble, sand and gravel, and clay provide building and facing stones, sculpture material, mosaics, underground shelters and subway train networks, construction materials, pottery and ceramic glazes, cosmetics, and health treatment materials. Fossil resin (amber), spices (cumin, cinnamon, nutmeg, cardamom), precious stones (lapis lazuli, carnelian, turquoise), salt, phosphides, wild wheat,

lentils, and peas, olives, and natron (sodium-rich) glass are valuable exports. Oil and natural gas are present offshore. Pine forests, shrubs, olive, and nut trees provide habitat for wildlife, especially birds and small mammals.

Several of these resources are important to industry, food, and even warfare. For example, Levant salt was used as primitive currency, for salting soil and wells during warfare in the ancient world, preserving meat, fish, vegetables, and fruit (including olives), processing leather, glazing ceramics, dyeing textiles, separating gold from silver, and making cheese, medicines, and cosmetics.

Much of the Levant has limited arable land which needs irrigation and fertilization to be productive. Most of the region consists of outcrops of fresh or weathered limestone covered by a thin veneer of calcareous soil.

According to the specialists of the UN Environment Programme World Conservation Monitoring Centre<sup>1</sup> the Levant is part of the Aegean Sea and East Mediterranean Mixed Forest bioregion. Levantine forests are characterized by Calabrian Pine in the north and Aleppo Pine in the south. Levantine shorelines produce natural European olive, carob, Kermes oak, green olive, and storax balsam (oily herbal medical resins).

The Levant is not known to have excess fresh water, coal, lignite, rare earth minerals, or uranium. However, rainfall and snow melt in its inland mountain ranges feed intermittent freshwater rivers, underground springs, and perennial groundwater.

The U.S. Geological Survey estimates that Levantine reserves include about 1.7 billion barrels of oil, and 3.5 trillion cubic meters of natural gas.<sup>2</sup>

These natural resources have economic value which makes human subsistence, growth, and development function.

Fig. 1 is a geologic map of the Levant. According to Y. Avni,<sup>3</sup> the main physiographic features are the Lebanon Mountains in the east to the Sinai Peninsula in the southwest and the Mediterranean Sea to the west. The region is situated at the boundary of the northeastern African and northwestern Arabian Plates. It borders the eastern Mediterranean Levantine Basin. It includes 3000-meter-high mountain ranges and deep structural depressions as subsea basins. It reflects its tectonic and landscape evolution and its mainly late Miocene history. In the last 40 million years, it became active in the plate boundary dissecting the Levant along the Dead Sea Transform.

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<sup>1</sup> Martin *et al.*, 2019.

<sup>2</sup> Alhas, 2019.

<sup>3</sup> Avni, 2017.

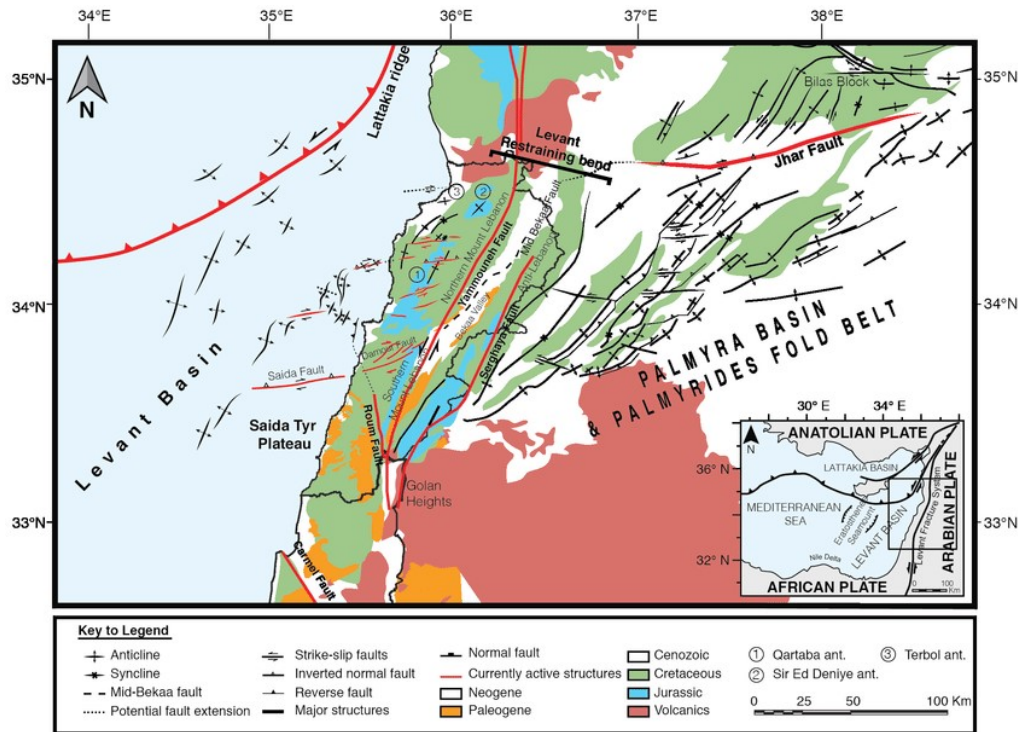




**Fig. 1:** Geologic Map of the Levant Showing Major Terranes (Rybakov *et al.*, 2011; derived from the Internet site of Cornell University <http://atlas.geo.cornell.edu/projects.html>)

According to R. Ghalayini and other researchers,<sup>4</sup> the Lebanon Margin, offshore of Lebanon in the Eastern Mediterranean Sea, there are four domains: 1. The distal Levant Basin; 2. The Lattakia Ridge; 3. The Levant Margin; and 4. The Onshore. Each domain is characterized by a particular structural style and stratigraphic architecture, resulting in different source-reservoir traps. The Levant Margin is a carbonate stratigraphic petroleum trap.

<sup>4</sup> Ghalayini *et al.*, 2018.



**Fig. 2:** Geologic structures of the Eastern Levantine Margin (Ghalayini *et al.*, 2018)

Fig. 2 shows the geologic structures of the Eastern Levantine Margin, important for its petroleum reserves. Oil and natural gas traps in the off-shore Levantine are both structural and stratigraphic.<sup>5</sup>



**Fig. 3a:** Tripoli, Lebanon, spring house from natural fresh-water spring from inland limestone grotto to reservoir built in the coastal Mediterranean Sea by Phoenician barrage (dam), updated by Colonial France (Popkin, 7 February 2011)

<sup>5</sup> Marlow *et al.*, 2011.





**Fig. 3b:** Tripoli, Lebanon, spring house from natural fresh-water spring from inland limestone grotto to reservoir built in the coastal Mediterranean Sea by Phoenician barrage (dam), updated by Colonial France (Popkin, 7 February 2011)



**Fig. 4.** Dutch female and American male tourists treating themselves to medicinal clay body treatment at the Dead Sea, Jordan (Popkin, 23 September 2005)

**Table 1.** Summary of climate, terrain, cultural, and natural resources of the Levant

	<b>Turkey</b>
<b>Climate</b>	Temperate; hot, dry summers with mild, wet winters; harsher in interior
<b>Terrain</b>	High central plateau (Anatolia); narrow coastal plain; several mountain ranges; forests
<b>Cultural resource</b>	Antiquities, tourism
<b>Natural resources</b>	Coal, iron ore, copper, chromium, antimony, mercury, gold, barite, borate, celestite (strontium), emery, feldspar, limestone, magnesite, marble, perlite, pumice, pyrites (sulfur), clay, arable land, hydropower, forests
<b>Major natural resource industry</b>	Textiles, food processing, mining (coal, chromate, copper, boron), steel, petroleum, lumber, paper
<b>Natural hazards</b>	Severe earthquakes, especially in northern Turkey, along an arc extending from the Sea of Marmara to Lake Van; landslides; flooding
<b>Volcanism</b>	Limited volcanic activity; its three historically active volcanoes; Ararat, Nemrut Dagi, and Tendurek Dagi have not erupted since the 19th century or earlier
<b>Environmental issues</b>	Water pollution from dumping of chemicals and detergents; air pollution, particularly in urban areas; deforestation; land degradation; concern for oil spills from increasing Bosphorus ship traffic; conservation of biodiversity
<b>Water resources and lakes</b>	
<b>Major rivers</b>	Euphrates river source (shared with Syria, Iran, and Iraq [river mouth]) - 3,596 km; Tigris River source (shared with Syria, Iran, and Iraq [river mouth]) - 1,950 km

	<b>Greece</b>
<b>Climate</b>	Temperate; mild, wet winters; hot, dry summers
<b>Terrain</b>	Mountainous with ranges extending into the sea as peninsulas or chains of islands
<b>Cultural resource</b>	Antiquities, tourism
<b>Natural resources</b>	Lignite, petroleum, iron ore, bauxite, lead, zinc, nickel, magnesite, marble, salt, hydropower potential, forests
<b>Major natural resource industry</b>	Coal, oil, natural gas, and solar, wind, hydroelectric, geothermal, and tidal wave energy
<b>Natural hazards</b>	Severe earthquakes

	<b>Greece</b>
<b>Volcanism</b>	Santorini (367 m) has been deemed a Decade Volcano by the International Association of Volcanology and Chemistry of the Earth's Interior, worthy of study due to its explosive history and close proximity to human populations; although there have been very few eruptions in recent centuries, Methana and Nisyros in the Aegean are classified as historically active
<b>Environmental issues</b>	Air pollution; air emissions from transport and electricity power stations; water pollution; degradation of coastal zones; loss of biodiversity in terrestrial and marine ecosystems; increasing municipal and industrial waste
<b>Water resources and lakes</b>	
<b>Major rivers</b>	

	<b>Cyprus</b>
<b>Climate</b>	Temperate; Mediterranean with hot, dry summers and cool winters
<b>Terrain</b>	Central plain with mountains to north and south; scattered but significant plains along southern coast
<b>Cultural resource</b>	Tourism
<b>Natural resources</b>	Copper, pyrites, asbestos, gypsum, timber, salt, marble, clay earth pigment
<b>Major natural resource industry</b>	Solar, wind, hydroelectric, geothermal, and tidal wave energy
<b>Natural hazards</b>	Moderate earthquake activity; droughts
<b>Volcanism</b>	
<b>Environmental issues</b>	Water resource problems (no natural reservoir catchments, seasonal disparity in rainfall, sea water intrusion to island's largest aquifer, increased salination in the north); water pollution from sewage, industrial wastes, and pesticides; coastal degradation; erosion; loss of wildlife habitats from urbanization
<b>Water resources and lakes</b>	
<b>Major rivers</b>	

	<b>Syria</b>
<b>Climate</b>	Mostly desert; hot, dry, sunny summers (June to August) and mild, rainy winters (December to February) along coast; cold weather with snow or sleet periodically in Damascus

	<b>Syria</b>
<b>Terrain</b>	Primarily semiarid and desert plateau; narrow coastal plain; mountains in west
<b>Cultural resource</b>	Antiquities
<b>Natural resources</b>	Petroleum, phosphates, chrome and manganese ores, asphalt, iron ore, rock salt, marble, gypsum, hydropower
<b>Major natural resource industry</b>	Petroleum, textiles, food processing, tobacco, phosphate rock mining, cement, oil seeds crushing
<b>Natural hazards</b>	Dust storms, sandstorms
<b>Volcanism</b>	Two historically active volcanoes, Es Safa and an unnamed volcano near the Turkish border have not erupted in centuries
<b>Environmental issues</b>	Deforestation; overgrazing; soil erosion; desertification; depletion of water resources; water pollution from raw sewage and petroleum refining wastes; inadequate potable water
<b>Water resources and lakes</b>	
<b>Major rivers</b>	Euphrates (shared with Turkey [source], Iran, and Iraq [mouth]) - 3,596 km; Tigris (shared with Turkey, Iran, and Iraq [mouth]) - 1,950 km

	<b>Lebanon</b>
<b>Climate</b>	Mediterranean; mild to cool, wet winters with hot, dry summers; the Lebanon Mountains experience heavy winter snows
<b>Terrain</b>	Narrow coastal plain; El Beqaa Valley separates Lebanon and Anti-Lebanon Mountains
<b>Cultural resource</b>	Antiquities
<b>Natural resources</b>	Limestone, iron ore, salt, water-surplus state in a water-deficit region, arable land
<b>Major natural resource industry</b>	Agricultural products, tourism, food processing, wine, grapes, jewelry, cement, textiles, mineral and chemical products, wood and furniture products, oil refining, metal fabricating, gold, diamonds, wood furniture
<b>Natural hazards</b>	Earthquakes; dust storms, sandstorms
<b>Volcanism</b>	
<b>Environmental issues</b>	Deforestation; soil deterioration, erosion; desertification; species loss; air pollution in Beirut from vehicular traffic and the burning of industrial wastes; pollution of coastal waters from raw sewage and oil spills; waste-water management
<b>Water resources and lakes</b>	

	<b>Lebanon</b>
<b>Major rivers</b>	

	<b>Jordan</b>
<b>Climate</b>	Mostly arid desert; rainy season in west (November to April)
<b>Terrain</b>	Mostly arid desert plateau; a great north-south geological rift along the west of the country is the dominant topographical feature and includes the Jordan River Valley, the Dead Sea, and the Jordanian Highlands
<b>Cultural resource</b>	Antiquities, tourism
<b>Natural resources</b>	Phosphates, potash, shale oil
<b>Major natural resource industry</b>	Agricultural products; tomatoes, poultry, olives, milk, potatoes, cucumbers, vegetables, watermelons, green chillies/peppers, peaches / nectarines; tourism, clothing, fertilizer, potash, phosphate mining, petroleum refining, cement, inorganic chemicals, fertilizers, clothing and apparel, calcium phosphates, phosphoric acid, solar and wind energy
<b>Natural hazards</b>	Droughts; periodic earthquakes; flash floods
<b>Volcanism</b>	
<b>Environmental issues</b>	Limited natural freshwater resources; declining water table; salinity; deforestation; overgrazing; soil erosion; desertification; biodiversity and ecosystem damage/loss
<b>Water resources and lakes</b>	
<b>Major rivers</b>	

	<b>Israel/ Palestine/ Sinai</b>
<b>Climate</b>	Temperate, hot and dry in south and deserts
<b>Terrain</b>	Negev and Sinai Deserts; low coastal plain; central Mountains; Jordan Rift Valley
<b>Cultural resource</b>	Antiquities, tourism, religious sites
<b>Natural resources</b>	Timber, potash, copper ore, natural gas, phosphate rock, magnesium bromide, clays, sand
<b>Major natural resource industry</b>	Agricultural product, milk, potatoes, poultry, tomatoes, carrots, turnips, tangerines/mandarins, green chillies/peppers, eggs, vegetables; natural gas
<b>Natural hazards</b>	Spring and summer sandstorms; droughts; periodic earthquakes
<b>Volcanism</b>	



	<b>Israel/ Palestine/ Sinai</b>
<b>Environmental issues</b>	Limited arable land and restricted natural freshwater resources; desertification; air pollution from industrial and vehicle emissions; groundwater pollution from industrial and domestic waste, chemical fertilizers, and pesticides
<b>Water resources and lakes</b>	<p>Lake Tiberias (Sea of Galilee) is an important freshwater source; the Dead Sea is the second saltiest body of water in the world (after Lake Assal in Djibouti) note 2: the Malham Cave in Mount Sodom is the world's longest salt cave at 10 km (6 mi); its survey is not complete and its length will undoubtedly increase; Mount Sodom is actually a hill some 220 m (722 ft) high that is 80% salt (multiple salt layers covered by a veneer of rock)</p> <p>Major lakes (area sq km) saltwater lake(s): Dead Sea (shared with Jordan and West Bank) - 1,020 sq km note - endorheic hypersaline lake; 9.6 times saltier than the ocean; lake shore is 431 meters below sea level Total water withdrawal (2020 est.) municipal: 1 billion cubic meters industrial: 100 million cubic meters agricultural: 1.2 billion cubic meters Total renewable water resources 1.78 billion cubic meters (2020 est.)</p>
<b>Major rivers</b>	

Sources: CIA, 2023.

### 3. Discussion and Conclusion

As seen in Tab. 1, the natural resources of the Levant are diverse, if limited. Although no effort was made to quantify its economic worth, other than tundra, ice-covered regions, and large deserts, its economic value is limited. This can be confirmed by a low national gross domestic product from natural resources within the region. Even the recent exploration and development of offshore oil and gas in the Eastern Mediterranean Sea are unlikely to make the Levant a natural resource based economic giant.

Nonetheless, the region's diversity would make it a popular tourist and retirement destiny for its rich history, culture, beauty, and diversity, and its role in establishment of the major western religions. As an American who has worked in the Levant for several decades, I can attest the great number of family, friends, neighbors, and colleagues who have been Levant tourists and became residents, despite conflict and wars in the region.

Some of this natural Levantine diversity includes topographic contrasts from coastal desert to inland snow-capped mountains, charming limestone

grottos and perennial fresh-water carbonate-rich springs, several interesting seas, and marketable rocks and minerals including cosmetic materials, and gentle, flat, and polished to rough and rugged, and raw landscapes.

**Author's comments.** Barney Paul Popkin is an American geologist and hydrologist. A former U.S. Agency for International Development Advisor and U.S. Geological Survey Hydrologist, he has over 50 years of international experience including the Levantine area from Syria to Egypt. Mr. Popkin is grateful for conversations with Amin Shaban of the Lebanon National Council for Research, Ronald Lubke of Metcalf & Eddy Engineers, David Brooks of Friends of the Earth/ Middle East, Carl Hodges of the University of Arizona Environmental Research Laboratory and Seawater Foundation, Sol Resnick of the Arizona Water Resources Research Center, Digger Jones of the USGS, Dan Deely of USAID, and publications from those organizations as well as the Central Intelligence Agency.

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